

**THE 2010 DESERT RATS SCIENCE OPERATIONS TEST: OUTCOMES AND LESSONS LEARNED.** D. B. Eppler<sup>1</sup> and the 2010 Desert RATS Science Operations Team<sup>2</sup>, 1. Exploration Sciences Office, Astromaterials Research and Exploration Sciences Directorate, Mail Code KX, NASA-Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058, [dean.b.eppler@nasa.gov](mailto:dean.b.eppler@nasa.gov); 2. Full name and affiliation list available from first author.

The Desert RATS 2010 Team tested a variety of science operations management techniques, applying experience gained during the manned Apollo missions and the robotic Mars missions. This test assessed integrated science operations management of human planetary exploration using real-time, tactical science operations to oversee daily crew science activities, and a “night shift” strategic science operations team to conduct strategic level assessment of science data and daily traverse results. In addition, an attempt was made to collect numerical metric data on the outcome of the science operations to assist test evaluation.

The two most important outcomes were 1) the production of significant (almost overwhelming) volume of data produced during daily traverse operations with two rovers, advanced imaging systems and well-trained, scientifically proficient crew-members, and 2) the degree to which the tactical team’s interaction with the surface crew enhanced science return. This interaction depended on continuous real-time voice and data communications, and the quality of science return from any human planetary exploration mission will be based strongly on the aggregate interaction between a well trained surface crew and a dedicated science operations support team using voice and imaging data from a planet’s surface. In addition, the scientific insight developed by both the science operations team and the crews could not be measurable by simple numerical quantities, and its value will be missed by a purely metric-based evaluation of test outcome. In particular, failure to recognize the critical importance of this qualitative type interaction may result in mission architecture choices that will reduce science return.

There were a number of important lessons that can be applied to future human science operations teams in support of human planetary exploration:

- 1) Science operations teams need to be led by senior scientists with a range of professional experience in geological sciences. In particular, these teams cannot be made up exclusively of junior scientists with little operational experience. Leadership is critical to providing guidance and varied points of view during operations during complex and often stressful missions.
- 2) Continuous communications with stable, high fidelity voice and image data gives better science

return than conditions where communications have long intervals between contacts. The scientific interaction between the crew and the science operations team that is available during continuous communications resulted in a significant improvement in the understanding of the science of the area explored. Reduced communications would result in a significant decrease in mission science return.

- 3) A diligent science operations team and a well-trained, scientifically competent astronaut crew can mitigate poor communications conditions, particularly when the communications conditions are anticipated and planned for. This test underscored the need for a science operations team that can adapt to changing conditions.
- 4) The volume of data coming out of any given day of this mission, particularly when compared to a robotic mission, was enormous. As the mission progressed, it became difficult for the strategic team to assimilate and evaluate the data during a nominal shift due to data management problems and data presentation techniques. In particular, the time consumed in attempting to evaluate recorded verbal data without a written transcript made detailed scientific analysis almost impossible within the given time constraints. The ability to generate written transcripts of verbal observations will be critical to the science analysis of any human exploration mission.
- 5) When operating with only two daily communications sessions, science analysis and return achieved by a strategic science team was directly related to how well the crew provided both the contextual descriptions of geology and the image data that illustrated the crews’ science descriptions. In particular, data retrieval problems or poor image data collected by the crew resulted, not surprisingly, in poor science return.
- 6) The science metrics collected on Desert RATS 2010 did not provide unambiguous data on the efficacy of particular approaches to science operations management. Although the data suggested some trends, there was not sufficient granularity in the data or specificity in the metrics to allow those trends to be understood on metric data alone.